Language and the Evolution of Modern Humans

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ABSTRACT

This paper discusses the role of linguistics in studying human evolution. In the preamble on major steps in the evolution of language, special attention is paid to the co-evolution of brain and evolution, and to the two major steps in the evolution of language. In the second section, three senses of the word "reconciliation" are considered: [1] between the out-of-Africa hypothesis and the multiregional continuity hypothesis, [2] among the various disciplines concerned with human evolution, and [3] between the effects of vertical transmission and those of horizontal transmission. In the third section, three specific uses for linguistics are discussed: [1] the grouping of languages as a way of grouping peoples, [2] the proto-lexicon as a source of prehistoric information, and [3] the dating of language splits as a resource for studying ancient migrations. In regard to the last topic, some possible uses of error matrices as a clue for horizontal transmission are discussed.

I. Major Steps in Language Evolution

The ability to communicate played an all-important role in the evolution of the hominids, as their inner lives and social structures became increasingly complex over the past two million years. Side by side with changes in their brain size and their behavior, as inferred from the bones and stones our ancestors have left behind, their mode of communication developed from some small, rudimentary set of prosodic sounds[2] and bodily gestures gradually into signals which are more efficient, and ultimately into the intricate language we have today. (Prosodic sounds are sounds which are relatively slow varying, based on modulations on the rhythm, amplitude, and fundamental frequency of the voice. They characterize the calls of many nonhuman primate groups. A definition of the term "modern humans" might be usefully based on the possession of true language, as we describe below.

Brain and language ***co-evolved*** in the sense that enhancement of one must have significantly stimulated the development of the other. While many writers on language evolution have commented on the obvious value of communication among individuals, the

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availability of a mental instrument for the storage and manipulation of large amounts of information within one's own mental world is certainly of no lesser importance.

There are two major steps in the evolution of the signals. The selection of vocal sounds over gestures conferred some obvious advantages: [1] the signals can be received in the dark, from a distant source, and across visual barriers, and [2] the body, particularly the hands, is freed for other tasks involved in hunting and gathering. Although other primates also use vocal signals, presumably early hominids developed a richer set of these, with better defined denotative content, rather than mere expressions of emotion.

The other major step is the development of syllable structure in the signal. Prosodic sounds typically require one or more seconds to pronounce, which is more demanding on immediate memory. Furthermore, they cannot be differentiated easily, since they are built from very few acoustic dimensions. On the other hand, syllables formed by vowels surrounded by consonants overcome both of these limitations; see [Wang 1989]. True language emerged when speech became organized primarily in terms of syllables, though prosodic sounds as well as gestures continue to exist as supplementary systems. It is reasonable to define modern humans as the first users of true language.

II. Three senses of "reconciliation"

The title of this conference is: The Origin and Past of Modern Humans - Toward a Reconciliation. In the present context, I can give three distinct senses to the word "reconciliation."

1. One sense of the word reconciliation has to do with the current debate on total replacement vs. regional continuity. Starkly phrased, I understand the question to be: Did the emigrants who left Africa between 100 Kys and 200 Kys ago totally wipe out all other hominid groups when they successively colonized the rest of the world? An affirmative answer would deny the possibility of any significant genetic admixture.

Perhaps I am unduly influenced by my studies of language contact, but a replacement theory in any complete and total sense seems too clean and too neat, and my intuition is that human prehistory must have been messier. I find myself inclining toward a scenario where horizontal transmission proceeds side by side with vertical transmission, in languages as well as in populations. Furthermore, it seems to me that the case for regional continuity in China, proposed by F.Weidenreich in the 1940s, is getting increased recognition, especially in the recent work of Wu Xinzhi吳新智 [Wu and Poirier 1995]. One would obviously prefer to have a complete fossil record for an infallible decision. But despite the incompleteness of the record, the suite of Asian morphological traits that Wu presents which can be traced all the way back to *H.erectus pekinensis* is intriguing, if not conclusive.

2. The second sense of reconciliation that occurred to me is to be achieved among the various disciplines concerned with human prehistory, and the many types of evidence they work with: genes and bones, words and stones. Interaction here is not only

desirable, but indispensable. Each discipline provides a window on the distant past. There is only one past for our species - one human prehistory, and different disciplines are looking at this past through different windows.

There is no reason to expect the disciplines to always tell exactly the same story, for the simple reason that peoples and cultures do not *always* move together. For example, people who are genetically quite distant may speak the same language, while people with the same genetic background may speak very distinct languages. However, since children typically get both their genes and their words from their parents, i would think that the default case will continue to be parallel phylogenies between the two. By comparing the results achieved independently by the various disciplines, we can arrive at a much fuller understanding of our past.

In such interdisciplinary contacts, it is useful not only to report to colleagues from other disciplines one's results, but to also discuss the methods used to arrive at these results. As a minimum, when the same term is used in different disciplines, we should be aware that they could have very different (even opposite) meanings; what the French call *faux amis*. A case in point is the term "drift", which has nearly opposite contents in linguistics and in genetics, as discussed by Cavalli-Sforza [1994:23]. More importantly, there is an understandable tendency for us to think that the results from other disciplines are more solid than they may really be; looking in from the outside we are less sensitive to the limitations and uncertainties than the workers within the discipline Having a more in-depth understanding of the methods behind the results gives investigators in other disciplines a sense of the strengths and weaknesses behind the results.

Even more importantly, sometimes the methods of one discipline can be effectively used in another discipline. A recent example of this transfer is the study by Cavalli-Sforza and myself [1986]. Using the model of isolation-by-distance developed from studies of genetic affinity across space by Malecot and Kimura, we studied linguistic affinity across a chain of 17 islands in Micronesia on the basis of several hundred words. While genes and words obviously will behave in distinct ways, the Micronesian study did yield interesting results on lexical replacement as a consequence of geographic distance. Since biology seems to be better developed at present in quantitative methods, I expect other models can be usefully transferred from biology to linguistics.

Another area where the methods of biology and linguistics converge is in the use of tree diagrams. According to Percival [1987:26], the earliest tree in botany was published by Robert Morrison in 1680. In zoology the earliest tree was published by Peter Simon Pallas in 1766, a scholar in the service of Catherine the Great [Wells, 1987:70]. But Percival notes that these early trees were simply logical schemata, with no evolutionary content. A phylogenetic tree in biology has to wait till 1809, from the pen of Lamarck.

This was quickly followed by the Danish linguist in 1819, Rasmus Rask, who drew a phylogenetic tree of depth 3 to indicate the historical relations among 10 Thracian languages. The most influential linguist in this area, however, was August Schleicher, who corresponded with Charles Darwin on evolutionary matters. Schleicher's trees were remarkable in that they were intended to be quantitative - that the branch lengths are significant. "The length of the lines indicates the amount of time which had elapsed and the distance between them degrees of relationship," as he himself stated in a work first published in 1863 [Percival, 1987:6]. In his day, Schleicher had neither the range of data

nor the numerical methods to make his trees precise. Nonetheless that he foresaw such a possibility is noteworthy.

3. Whereas the two senses of "reconciliation" discussed above are interdisciplinary in their implications, the third sense of the word points to a tension both within each discipline itself. Shortly after Schleicher published his family trees for the Indo-European languages, which accounted for only vertical transmission of linguistic traits, critical voices came to the fore, most notably from J.Schmidt and H.Schuchardt. The emphasis of these scholars was on the horizontal aspects of transmission. The following paragraph written by the American linguist L.Bloomfield in 1933, gives a succinct statement of their viewpoint:

> *"Schmidt showed that special resemblances can be found for any two branches of Indo-European, and that these special resemblances are most numerous in the case of branches which lie geographically nearest each other. ... Different linguistic changes may spread, like waves over a speech-area, and each change may be carried out over a part of the area that does not coincide with the part covered by an earlier change. The result of successive waves will be a network of isoglosses. Adjacent districts will resemble each other most; in whatever direction one travels, differences will increase with distance, as one crosses more and more isoglosslines."* Quoted in Cavalli-Sforza and Wang [1986:39].

Indeed, the conceptual basis here is very much like that of the isolation-by-distance model that geneticists have quantified. As mentioned above, this model has been successfully applied to a chain of Micronesian island, where the linguistic change we studied was replacement of words. Nonetheless, the family tree diagram has remained the dominant center-piece in most phylogenetic work, in linguistics and in biology.

Obviously, for both genes and words both horizontal and vertical transmission take place virtually all the time. Geneticists speak of admixtures, while linguists work with concepts such as linguistic areas, and creolization. Nonetheless, to the best of my knowledge, no methods have been developed in any discipline so far that can systematically and reliably sort out the effects of one mode of transmission from those of the other mode of transmission and relate the two kinds of effects within a coherent framework. The primary difficulty here is that every linguistic trait which has been studied so far is capable of being transmitted either vertically or horizontally, be it a sound, a word, or a grammatical pattern. However, the development of such methods is a central need for the reconciliation of the two modes of transmission for all the disciplines concerned with prehistory. I will return to this issue in a later section of this paper.

III. Some uses of linguistics in the study of human evolution

There are three areas in which linguistics can be useful in the study of prehistory. [1] The first of these is the determination of the genetic relations among languages. As Darwin noted as early as 1859, we should expect a high degree of correlation between how languages group and how peoples group in the default case. In fact, both good correlations and poor correlations between the two hold valuable information on human

evolution. [2] The second area has to do with reconstructing words for earlier times. Through these words we can get a glimpse of the material as well as nonmaterial culture of the speakers of these words. [3] The third area is concerned with dating various events, in either absolute or relative time. These events may be language divergence or language contact, actuated by population movements.

All three of these areas involve making inferences regarding earlier states of the relevant languages. In particular, a central concept that we will need to use repeatedly here is that of a ***cognate***. For example, let us observe, without proof for now, that the English word "water" and the German word "Wasser" are members of a cognate set; or, simply that the two words are cognates of each other. Such an observation is a claim that English and German have descended from the same parent language, and that the two words have descended from the same word in that parent language. Indeed, even if the parent language was never written down, it is sometimes possible to ***reconstruct*** what that word might have sounded like without the aid of any textual evidence. Thus we can reconstruct the word for water in Proto-Indo-European, an ancient language from which English and German, as well as a host of other languages have descended. That word is ***wed**, where the "*" in front of the word indicates that it is a reconstructed form [Watkins 1985:73]. Similarly, the prefix "proto-" in front of a language name indicates that the language is a reconstructed one. We will now discuss these three areas in turn.

[1] First, the determination of genetic relations. For purposes of the present discussion, let us accept the hypothesis of monogenesis, which holds that all human languages we know of, extant or extinct, are genetically related; see Freedman and Wang 1996 for discussion. Then a statement that the languages A, B, and C are all related is quite vacuous, since it follows trivially from the hypothesis. On the other hand, it immediately becomes interesting if we can state that these three languages are more closely related to each other than to other language in the world. It is in this sense that we shall use the term "genetically related" in the discussion here. In some cases, we may be able to state additionally that A and B are closer to each other than either is to C, a grouping we may represent as ((A,B),C). The determination of genetic relations, then, is really a matter of grouping and subgrouping of languages into such hierarchies of family units. In the case of ((A,B),C), AB is a family, and ABC is a family; but not AC or BC.

The evidence for determining genetic relations among languages is a probabilistic one, as was recognized in these words of William Jones from his famous lecture of 1786, given in Calcutta, which laid the foundation for studying language prehistory in general and for reconstructing Proto-Indo-European in particular [Cannon 1991: 31] :

> *The Sanskrit language, whatever be its antiquity, is of a wonderful structure; more perfect than the Greek, more copious than the Latin, and more exquisitely refined than either, yet bearing to both of them a stronger affinity, both in the roots of verbs and in the forms of grammar,* ***than could possibly have been produced by accident****; so strong indeed, that no philologer could examine them all three, without believing them to have sprung from some common source, which, perhaps, no longer exists;* ... [emphasis added].

If two or more languages show resemblances that cannot be explained by [a] chance or by various sorts of [b] sound symbolism, then these resemblances must be due to either [c]

horizontal or [d] vertical transmission. Our primary interest here is in [d], vertical transmission. Further down in that same paragraph, Jones added Gothic, Celtic, and Persian, to the Sanskrit, Greek and Latin mentioned above; all six of these languages are related by vertical transmission, and have been important in the reconstruction of Proto-Indo-European.

It should also be added that the evidence for genetic relations among languages is incremental in nature, that the deciding factor is the cumulative weight rather than any single trait or any particular argument. Since linguists at present have no uniform standard on how to weigh various types of evidence with respect to each other, and on how much evidence is enough evidence, controversies will arise when different linguists arrive at different genetic conclusions regarding a group of languages even when presented with the same set of evidence. A case in point is the genetic position of the Japanese language, which we will now briefly discuss under the headings of six types of linguistic data. They are: [i] writing, [ii] typological similarity, [iii] vocabulary, [iv] sound correspondence, [v] morphology, and [vi] basic words.

[i] *Writing*. The casual observer, noticing the strong similarities between Japanese and Chinese writing, is likely to reason that the two languages are closely related. But of course, we cannot reason from the writing system to the genetic position of the corresponding (spoken) language. On this faulty reasoning, all languages written with the Latin alphabet would be grouped together genetically, thereby including wrongly such languages as English, Finnish and Turkish, and Vietnamese. A language may replace its writing system. Turkish adopted the Latin alphabet to replace an Arabic system of writing, and Vietnamese adopted the Latin alphabet to replace Chinese characters, both cases being examples of horizontal transmission.

[ii] *Typological similarity*. Consider the case of syntax. Since the basic elements of syntax are few in number, the ways in which these elements can be ordered are correspondingly limited. The elements Subject, Verb, and Object, for instance, can only be ordered in six possible patterns: SVO, SOV, VSO, OVS, OSV and VOS. Given that there are some 6000 languages in the world, the probability is high that any pair of randomly chosen pair of languages will share the same pattern. The Japanese pattern of SOV is indeed shared by numerous languages of the world, merely by chance, from which no genetic inference can be drawn. Similar observations can be made about other syntactic orderings.

In the case of Japanese, however, there is a kind of typological similarity that has greater probabilistic significance. This is the presence of vowel harmony in Old Japanese, as discussed by Hattori [1966]. Vowel harmony is a linguistic trait that is found in some languages, which requires that all the vowels within a word to belong to the same subset of vowels. Unlike the patterns of syntactic order discussed above, from which each language must choose, vowel harmony is a relatively rare trait for which there is no intrinsic necessity. The fact that Japanese shares this trait with Korean and Altaic, as documented by Hattori [1968] provides an increment of evidence that these languages are related.

[iii] *Vocabulary*. Looking at the stock of Japanese words may again mislead one to group it with Chinese, since there is a substantial lexical sharing between the two

languages. The Japanese vocabulary can be divided into three major strata: *Wago* 和語 refers to words which are judged to be indigenous to the language; these words hold the key to the genetic position of the Japanese language. *Kango* 漢語 refers words borrowed from Chinese, many of them entering the Japanese language well over a thousand years ago; most of these words have several pronunciations due to borrowings at different times and from different Chinese dialects. And *gairaigo* 外來語 refers to words mostly borrowed from European languages over the past century; the number of these words has increased significantly in recent decades, especially due to borrowings from English. In fact, there are many meanings which can be expressed in each of the three strata, with only minor differences in connotation. Here are some examples from Shibatani [1987:133]:

neaning:	cancellation	detour	idea	acrobat
wago:	torikesi	mawarimiti	omoituki	karuwaza
kango:	kaiyaku 解約	ukairo 迂回路	tyakusoo 著想	kyokugei 曲藝
gairaigo:	kyanseru	baipasu	aidea	akurobatto

Most estimates put kango at over 50% of the Japanese vocabulary. This is in the same order as the number of words of French origin which entered the English vocabulary since 1066, when William the Conqueror of Normandy defeated England. Similarly, there are meanings which can be expressed in either stratum:

English	handbook	unbelievable
French	manual	incredible

It is typical in such cases of horizontal transmission that the words are at the level of cultural vocabulary. For detecting vertical transmission, it is important not to be misled by cultural vocabulary, but to focus our attention to the basic words of each language, words that any language is very likely to have developed independent of contact with other languages and cultures. We will turn to this important topic shortly.

[iv] *Sound correspondence*. The discovery that sounds often change regularly from the parent language to the various daughter language is one of the triumphs of modern linguistics; these regular changes are sometimes called "sound laws". This regularity is the basis for our observation earlier that English "water" and German "Wasser" [pronounced with an initial "v" sound] are cognates, with the corollary that English and German are closely related. Indeed we can produce many pairs of related words where English "w" corresponds to German "v" or English "t" corresponds to German "s". Thus linguists speak highly of sound correspondence as a condition for genetic relatedness. However, it is important to note that while the existence of sound correspondence is a ***necessary*** condition for genetic relatedness, it is not a ***sufficient*** one.

This point can be illustrated with the many sound correspondences that can be demonstrated for Chinese and Japanese, as shown below. All the forms discussed below are kango words, that is, words imported into the Japanese vocabulary from Chinese. In the first set of forms, the Chinese sound at the end of the syllable that is spelled "ng" corresponds regularly to the vowel "o" in Japanese.

Chinese	Japanese
ŋg	*=o:*

wang	王	o:
yang	陽	yo:
lang	浪	ro:
mang	盲	mo:
fang	方	ho:
kong	孔	ko:
dong	東	to:
song	宋	so:
nong	農	no:
ding	丁	cho:
qing	情	jo:
xing	星	sho:
ming	命	myo:
ling	嶺	ryo:
bing	冰	hyo:
bing	病	byo:

The second set of forms below is a little more complicated. In the upper forms, the Chinese "h" sound at the beginning of the syllable corresponds tc "k" in Japanese. In the lower forms, however, the "h" sound has changed into a sound that is spelled "x" in Chinese, but this happens only when the following vowel in Chinese is an "i". This is a very prevalent type of change in the languages of the world, and is known as "palatalization." In Japanese, for example, it is due to palatalization that before the vowel "i" an "s" sound is pronounced like "she", a "z" sound is pronounced like "gee", a "t" sound is pronounced like "chee", etc.

Chinese		Japanese
	h=k	
hu	壺	ko
he	鶴	kaku
hei	黒	koku
hai	海	kai
hua	花	ka
hua	滑	kotsu
huo	活	katsu
han	漢	kan
hun	婚	kon
huang	黄	ko:
	h > x	
xi	喜	ki
xi	系	kei
xiu	休	kyu:
xin	欣	kin
xian	險	ken
xiang	向	kyo:

This added complication of palatalization does not reduce the regularity of the sound correspondence between the two languages. The Chinese forms above are based on the pronunciation of the dialect of Beijing. It is often the case that language changes fastest in cultural and political centers, presumably because of the greater linguistic diversity and greater density of linguistic interaction at such places. This palatalization has not taken place in many other dialects of Chinese, for instance, in Cantonese, where the "h" remains "h". The actual situation is much more complicated than the discussion here reveals, for there are actually several layers of vocabulary within the kango stratum, depending on the date and place of origin of the horizontal transmission. Sometimes the same word may be borrowed several times, resulting in different kango pronunciations, e.g., the Chinese word 筆 "writing instrument" is pronounced "fude" from an earlier borrowing, and "hitsu" from a later borrowing. In the light of these complications, the analysis of sound correspondences is often an intricate process.

However, without going into all the linguistic technicalities, the point to be noted here is that the sound correspondence shown above for Chinese and Japanese is no proof that the two languages are genetically related, since we know that the kango words were all borrowed during historical times. Strictly speaking, then, these words are not cognates, but ***pseudo-cognates***, since the languages turn out to be not genetically related, even though the words trace back to a common source. While we expect genetically related languages to exhibit sound correspondences, sound correspondences do not imply genetic relatedness since they can result from massive horizontal transmission. In short, the implication relation here is not symmetric.

The sound correspondences shown above are quite easy to see. Because the sound changes reflected in them operated relatively recently, the correspondences can be demonstrated with modern forms. This situation contrasts sharply with the correspondences between reconstructed form in Japanese and in various Altaic languages. These have been attempted by Whitman [1990] to account for the loss of certain consonants when these occurred between vowels in pre-Old Japanese, and by Vovin [1996] to account for the development of the so-called "pitch accent" in Japanese. The challenge in such attempts is much greater because inferences need to be built upon inferences. Nonetheless, if we are to say anything about language relationships which go back several thousand years, these efforts are unavoidable.

[v] *Morphology*. In every language, words can be grouped into various types of sets which exhibit certain morphological traits. Whereas individual words can be easily borrowed from one language into another, these morphological traits can be transmitted only if whole sets of words are transmitted. Since the latter is much less probable than the former, morphology has been rightfully regarded as valuable evidence for genetic relationships. This evidence is all the stronger if irregular traits are shared in addition to the regular traits. It would be strong evidence for vertical transmission.

This is the situation, for instance, with both adjectives and verbs when we compare English and German., as can be seen in the following examples. Such data point convincingly to the close genetic relation between the two languages, even though English is swamped with French words.

Adjectives - regular	English:	thick	thicker	thickest
	German:	dick	dicker	dickest

Adjectives - irregular	English:	good	better	best
	German:	gut	besser	best
Verbs - regular	English:	love	loved	
	German:	lieben	liebte	
Verbs - irregular	English:	think	thought	
	German:	denken	dachte	

Once again, when we come to the Japanese case, the situation is much more difficult because of the much greater time depth. Nonetheless, in an article entitled "Altaic origins of the Japanese verb classes", Miller [1981] presents a good amount of morphological evidence, much of which was compiled by Murayama some twenty years ago [1978]. It is well-known that the major classes of Japanese verbs are differentiated in their conjugational behavior according to the last segment of the stem. In particular, it depends on whether that segment is a consonant or a vowel, and if the latter, the nature of the vowel. For instance, the negative form of the verb *neru* "sleep" is *nenai*, whereas for *kara* "shear" it is *karanai*, rather than *kanai*. This difference in conjugation behavior, despite their superficial similarity, is due to the fact that the stem of *neru* is *ne-*, while the stem of *karu* is *kar-*; the former ends in a vowel while the latter ends in a consonant. Murayama and Miller has been able to trace these classes to their earlier forms in reconstructed Altaic morphology.

We noted earlier that evidence for genetic relationship takes the form of cumulative increments. With Hattori's work on vowel harmony, the results by Whitman and Vovin on sound correspondence, and the morphological connections established by Murayama and Miller, the evidence is building slowly but cumulatively in favor of the position that Japanese is a member of the Altaic family of languages, within which it is more closely related to Korean and Ainu [Patrie 1982].

[vi] *Basic words*. Earlier when we discussed vocabulary, we made a distinction between cultural words and basic words. This distinction is vital for separating horizontal transmission from vertical transmission. The most widely used list of meanings for eliciting basic words, which is intended to be equally applicable to all languages, is one proposed by the American linguist Morris Swadesh in the 1950s. These meanings are represented by English words, though theoretically that should be of no consequence. They can be divided into the the following six categories which label the columns in the table below. The largest category is constituted by the 21 meanings which refer to parts of the body. There are exactly 100 meanings in the first 21 rows of the table.

On the other had, the Russian linguist Sergei Starostin prefers to use a smaller list of 35 basic meanings, which he attributes to S.Y.Yakhontov; see Wang [1995: 249]. These meanings are represented by English words in bold face italics in the table below; and the last row in the table gives the subtotal of the Yakhontov meanings in each of the six categories. Three of these 35 meanings are not found in the Swadesh list; they are: salt, wind, and year. In the remainder of this paper, however, we will be referring to the Swadesh list.

Nature	Body	Animal	Verb	Adjective	Misc
ashes	belly	bird	bite	all	earth

2	bark	***blood***	claw	burn	big	***I***
3	cloud	***bone***	***dog***	come	black	***name***
4	***fire***	breast	feather	***die***	cold	night
5	leaf	***ear***	***fish***	drink	dry	not
6	man	***egg***	***horn***	eat	fat	***one***
7	***moon***	***eye***	***louse***	fly	***full***	road
8	mountain	foot	***tail***	***give***	good	that
	person	hair		hear	green	***this***
10	rain	***hand***		kill	long	***thou***
11	root	head		***know***	many	***two***
12	sand	heart		lie	***new***	we
13	seed	knee		say	red	***what***
14	smoke	liver		see	round	***who***
	star	meat		sit	small	
16	***stone***	mouth		sleep	warm	
17	***sun***	neck		stand	white	
18	tree	***nose***		swim	yellow	
19	***water***	skin		walk		
20	woman	***tongue***				
21		***tooth***				100
	salt				***year***	
	wind					
		9	5	3	2	9	35

The power of the basic words becomes immediately obvious when we compare the Chinese and Japanese vocabularies. Whereas we noted earlier that over 50% of Japanese words are kango, i.e., shared with Chinese, this number drops dramatically when we restrict the comparison to Swadesh's list of 100 basic words, as was done byVovin [1994a, 1994b]. Of these, only 6 are kango, as given below. Furthermore, it is significant that for 5 of these 6, there are wago words as well; e.g., for the meaning "heart", the kango word is "sinzoo" side by side with the wago word "kokoro." Only kango "niku," the word for "meat," has no indigenous counterpart in wago. Strictly speaking, only 1% of the basic words in Japanese has been replaced by horizontal transmission.

sinzoo	"heart"	kokoro
kanzoo	"liver"	kimo
zyosei	"woman"	onna
iti	"one"	hitotsu
ni	"two"	hutatsu
niku	"meat".	

However, when Vovin [1994b: 243] compared Japanese with Altaic languages, the situation changed decisively: Japanese shares approximately from 15 to 23 words with Korean, Manchu-Tungus, Mongolian, and Turkic in their basic words. This evidence adds to the observations referred to above in connection with vowel harmony, sound correspondences in terms of loss of medial consonant and development of pitch accent, and the morphology of verb classes. All these results accumulate to point in the direction of an Altaic orgin for the Japanese language.

When Swadesh proposed his list of 100 basic meanings, he speculated that basic words have a retention rate of approximately 80% per millennium. This means that if two languages diverged and evolved completely independently, they would share 64% of their basic words after 1000 years. Extending this reasoning, they would share 41% after 2000 years, and 17% after 3000 years. Swadesh called this method "glottochronology" [Wang, 1994]. If we restrict the method to a pair of languages at a time, one can easily see that basic words become too few from which to derive statistically significant results after the lapse of just several millennia. This indeed is a severe limitation of the method.

The actual situation surely must have been extremely complicated, with many waves of immigration into Japan from the north and from the south as well as from the east via Korea. These dates are in a plausible range, however, and are not inconsistent with current anthropological thinking concerning a "dual structure model for the population history of the Japanese," cf. Hanihara [1991], Omoto [1996]. The dates are also consonant with the finding by geneticists that a major wave from Korea brought in the Yayoi culture some 2300 years ago; cf. Horai [this volume].

Of the six types of linguistic data that may be relevant for determining genetic relationship which have been discussed above, basic words are clearly the most useful. They can be used quantitatively as well for dating language divergence; a topic we will turn to shortly. However, there are several conceptual problems which need to be satisfactorily defined and resolved before they can be used with complete confidence, not the least of which is the detection of cognates. Some of these have been analyzed by Wang and Shen [1992], in their effort to subgroup the dialects of Chinese. Other problems await future research.

[2] *The second area in which linguistics can be useful in the study of prehistory has to do with the reconstruction of a proto-lexicon.* If most of the languages descended from a proto-language have cognates for a particular word, we can reasonably infer that the proto-language had this word as well. And assuming that the proto-language has a particular word, then we can additionally made inferences concerning the material as well as nonmaterial culture of its speakers. The best examples available are from Indo-European studies.

From the fact that the reconstructed word ***sneig^{w}h-** , which has become "snow" in English, has descendents in almost all Indo-European languages, we can make the inference that the speakers of Proto-Indo-European lived in a region of the world that was cold enough to snow. In fact, the Proto-Indo-European form of the word has been largely preserved in modern Russian, where it is "snieg." The Proto-Indo-European word ***nepōt** has also largely preserved its form in modern Rumanian, while it has become "nephew" in English. It also has descendents in many languages, though the meaning is "grandson" is some of them. Its meaning has shifted still further, toward abstractness, in the English word "nepotism." From this word we can get a glimpse of family structure of a society that functioned many millennia ago.

But the part of Proto-Indo-European lexicon that has received the greatest attention over the past century is that which deals with religion, a topic that has been recently surveyed by Polome. A famous example is the reconstruction of the Proto-Indo-European word ***dyeu-pəter**, which is the source of the English word "Jupitar," the chief deity of the Indo-Europeans. We know that that the first part of the reconstructed

word is related to ***deiw-os**, meaning "to shine," and therefore probably connected conceptually to the sky [or heaven], from which light emanates. The second part, ***pəter**, which corresponds to "father" in English, is again found in most Indo-European languages. From these two parts, then, an important element of their religion is revealed In comparing the uses of linguistics and archeology, Watkins [1985. xvii] interprets the reconstructed word as follows:

> *The second element of the name of the chief god, ***dyeu-pəter**, is the general Indo-European word for FATHER, used not in the sense of father as parent, but with the meaning of the adult maile who is head of the household, the sense of Latin* pater familias. *For the Indo-Europeans, the society of the gods was conceived in the image of their own society, as patriarchal. The reconstructed words ***deiw-os** and ***dyeu-pəter** alone tell us more about the conceptual world of the Indo-Europeans than a roomful of graven images.*

It is certainly true that inferences from reconstructed lexicons can complement archeological findings in important ways; each offers a valuable glimpse into our prehistory. The great strides that Indo-European studies have made in this area can serve a model for research on the prehistory of many other parts of the world.

[3] The third area in which linguistics can be useful is concerned with dating prehistoric events. This is an area in which biology, chemistry and geology came together to produce some stunning results in recent decades. The advances came about with the recognition that certain chemical elements disintegrate at regular rates. and with the recognition that a sort of "molecular clock" can be devised to infer time from genetic mutations. Inspired by the advances in these fields, Swadesh proposed a method in the 1950s he called "glottochronology, " which was alluded to above in our discussion of basic words. This method is also called "lexicostatistics," a term that is intended to emphasize more the grouping use of the method rather than its dating use. There has accumulated a sizable literature on this method, mainly by anthropologists and linguists; an early critique is that by Hoijer [1956]. The most ambitious application of this method is to a large class of Indo-European languages recently reported by Dyen et al [1992].

In addition to the problems of determining what "basic words" are, glottochronology as a method is limited in that it deals with languages one pair at a time, thereby missing out on information which can be provided by the large number of subgroups in any group; cf. Wang [1994]. The numerical methods developed in biology are much more powerful, such as those by Cavalli-Sforza and Edwards [1967], Fitch and Margoliash [1967], and especially Saitou and Nei [1987]. Rather than pairwise comparisons, these latter methods yield phylogenetic trees which comprises the entire group of languages at once, where the branch lengths are additive. A century after Schleicher's initial attempts, biologists have developed precise methods for computing such trees.

The methods developed so far all face the problem that the number of trees gets extremely large as the number of languages gets beyond a dozen, posing a computational problem for personal computers or work-stations, where most of this type of research is done. These methods typically get around this problem by employing various heuristics to

eliminate unlikely trees without computing distances on them to arrive at the single best tree. In recent months, Qiao and Wang [Ms.] have developed an algorithm which computes distances exhaustively, i.e., going through every possible tree that can dominate the group of input languages. This algorithm makes use of matrix representations of tree structures, which are then decomposed for numerical solutions. The algorithm has been implemented within a system of parallel and distributed computing, which makes computation possible for as many as over twenty languages.

The hope is that with many of the trees made available to the investigator for the same data-set, detailed examination of the associated error matrices and negative branch lengths will lead to useful hypotheses which can separate vertical from horizontal transmission. The assumption is that much of the "irregularity" observed on these phylogenetic trees, which purport to represent vertical transmission, is due to horizontal transmission. The latter effect is called "admixture" in genetics, and "borrowing" in linguistics.

The separation of the effects from these two modes of transmission is indeed the fundamental challenge to all students of evolution, whether of human organisms or of our languages.

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